

# How can Massachusetts be running out of water?

(The basics of stream-aquifer interaction)

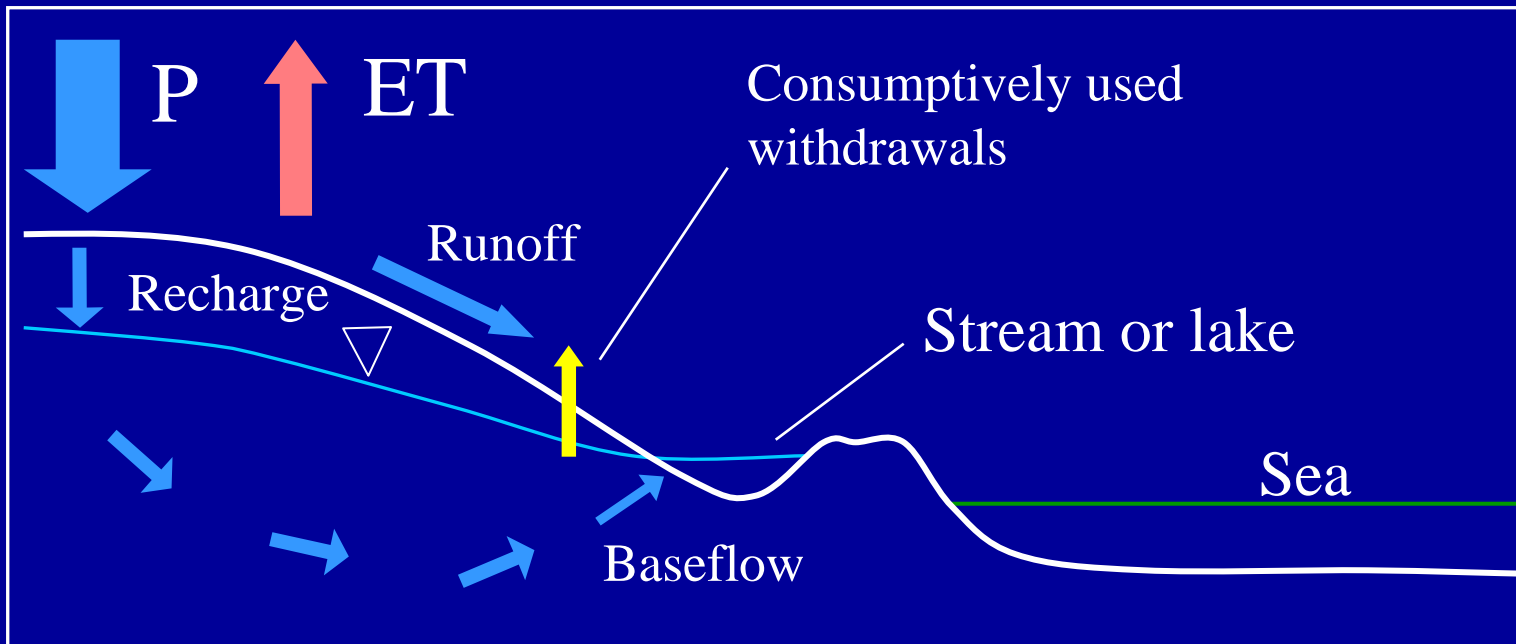
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Northborough, MA

Massachusetts Stream Flow Conference  
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# Massachusetts is “water rich”, right?...

- Abundant precipitation, moderate ET

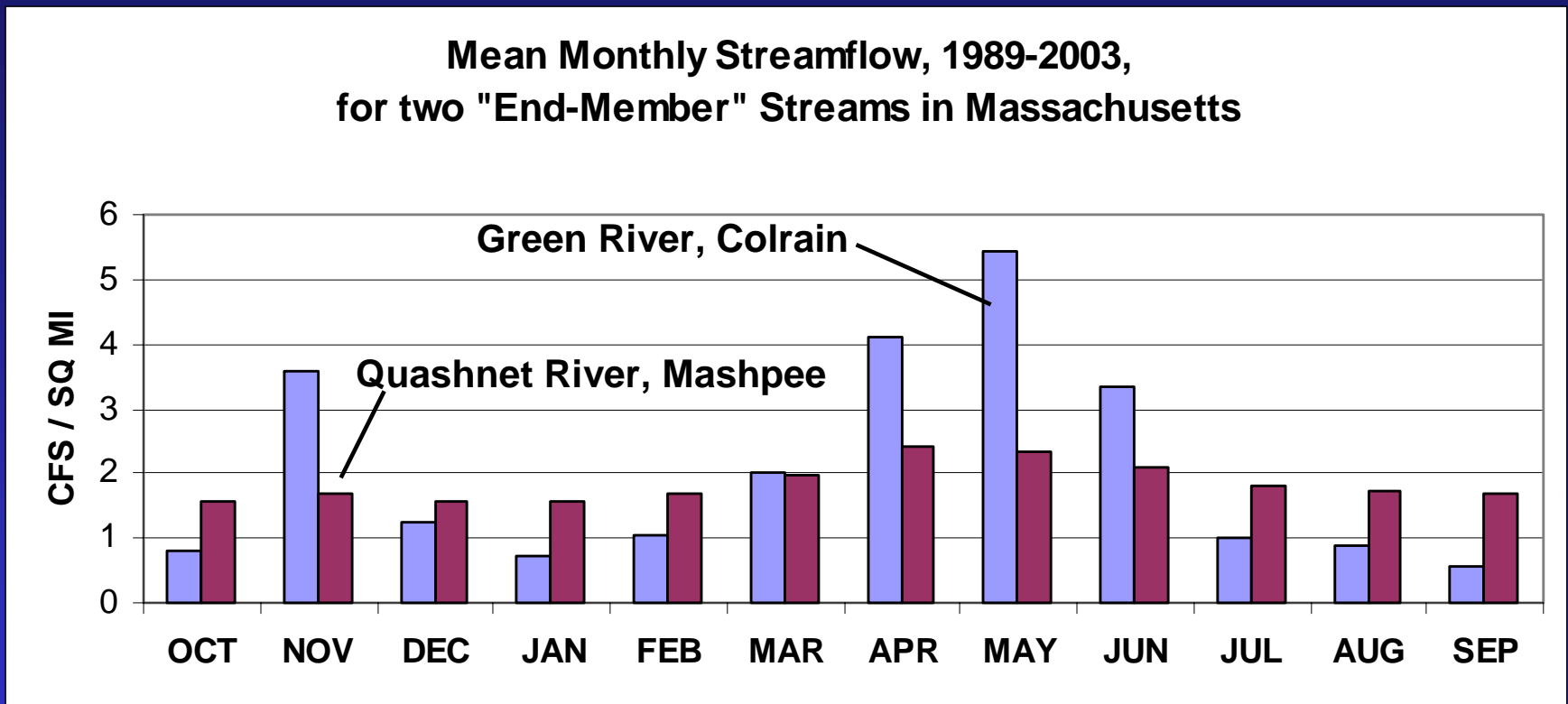


- Consumptive use typically < 5% of baseflow on a longterm average basis
- So what's the problem?

## Here's the problem:

1. Water availability (recharge) is highly seasonal; affects stream baseflow
2. Consumptive water use is seasonal and out of phase with recharge, affecting storage and baseflow.
3. Aquifer storage is often quite limited; affects baseflow
4. Water is exported downstream (or out of basin) after use.
5. Consciousness regarding flow and habitat has been raised (a good thing, not a problem).

# 1. Water availability: The annual streamflow cycle

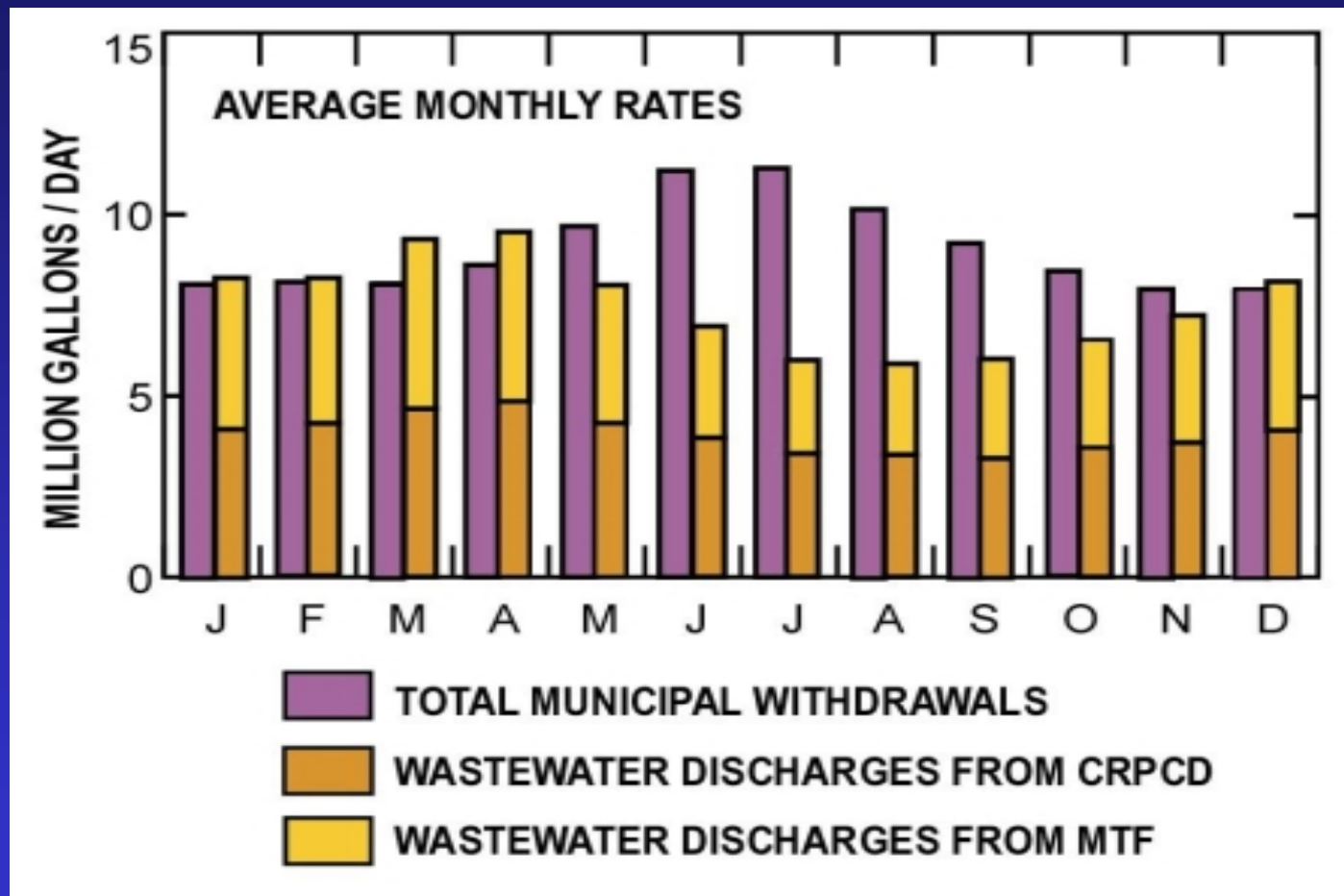


Green River– Western MA, steep basin, till dominated, frozen soils in winter

Quashnet River– Coastal MA, flat basin, sand-dominated, temperate winter

## 2. Water Use: The annual cycle

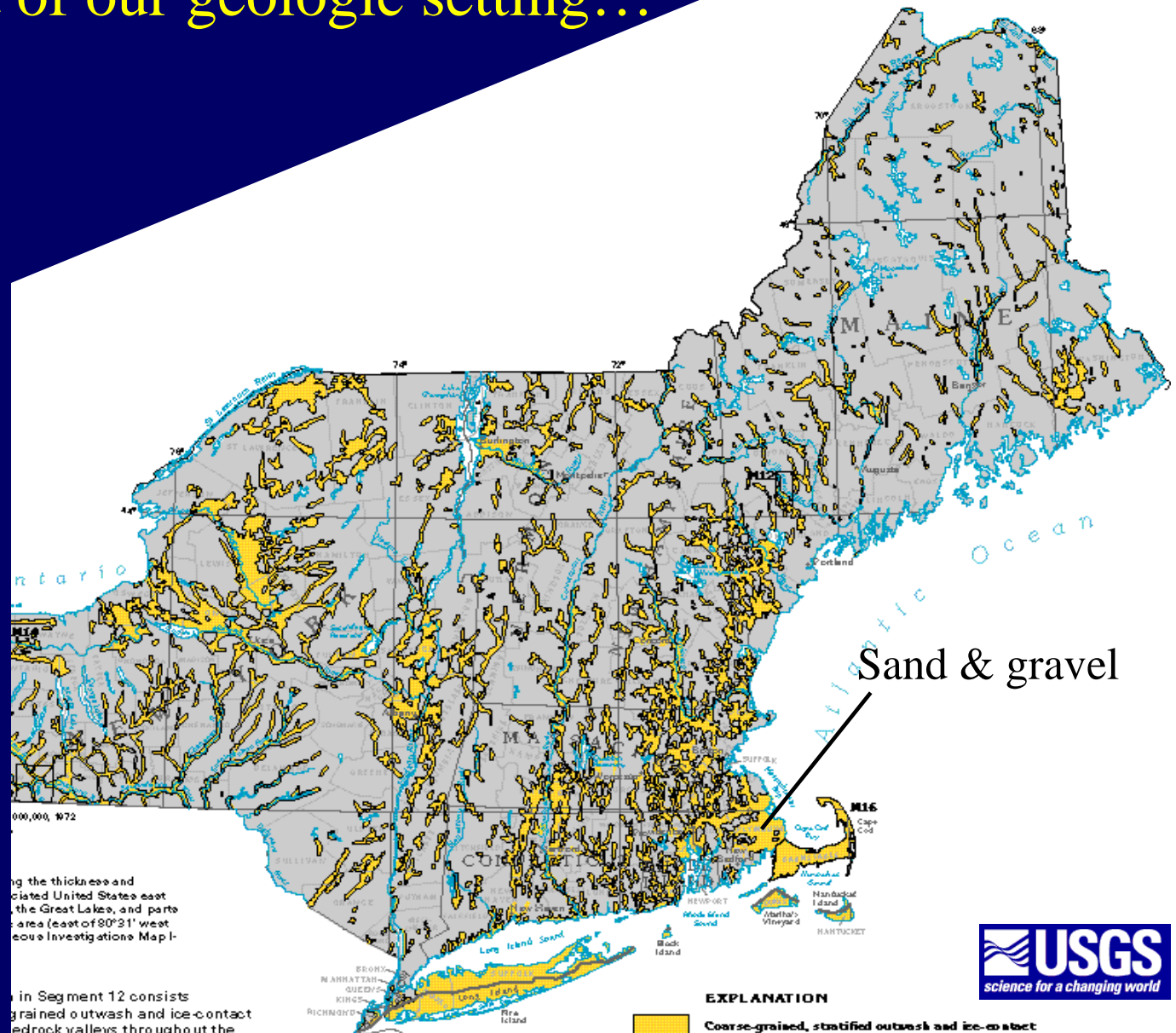
Upper  
Charles  
Basin,  
1989-98  
average  
withdrawals  
& returns



### 3. Aquifer Storage:

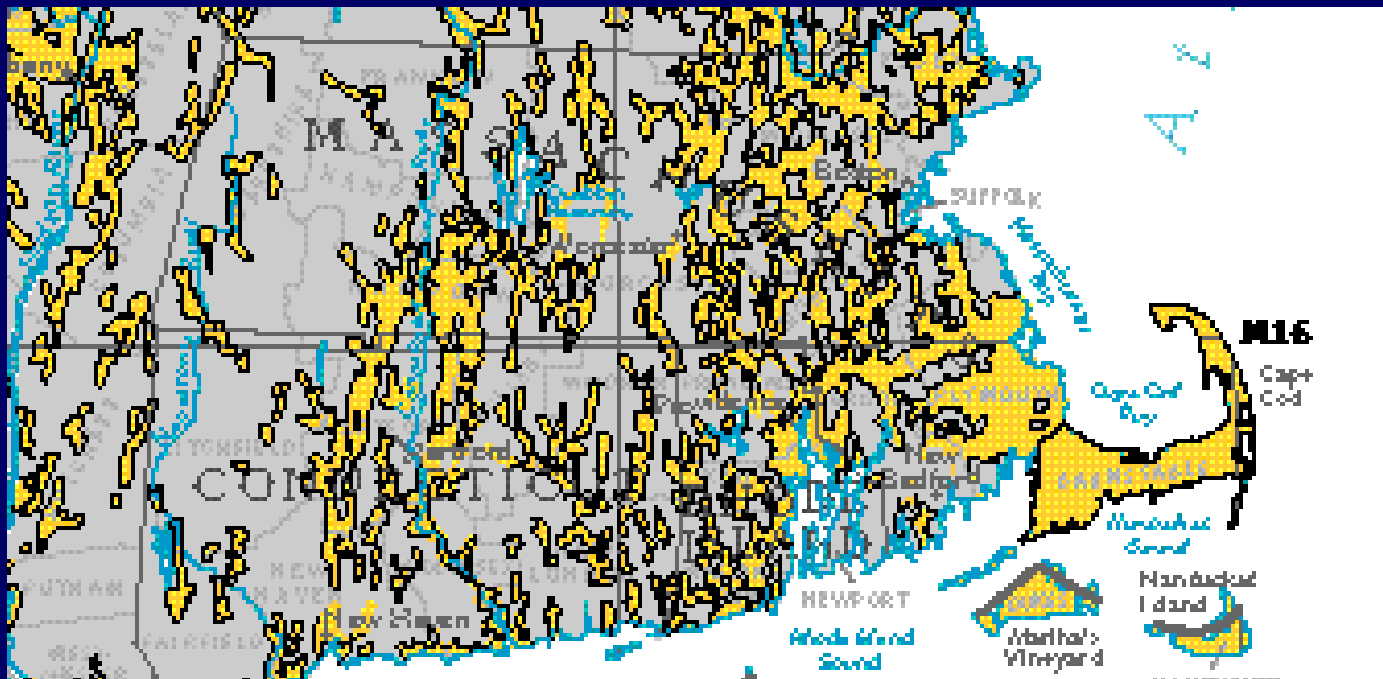
A key aspect of our geologic setting...

Map from:  
USGS Ground  
Water Atlas of the  
United States



### 3. Aquifer Storage:

- Glacial valley aquifers-- limited storage
- Outwash plain aquifers--large storage
- Massachusetts has both...

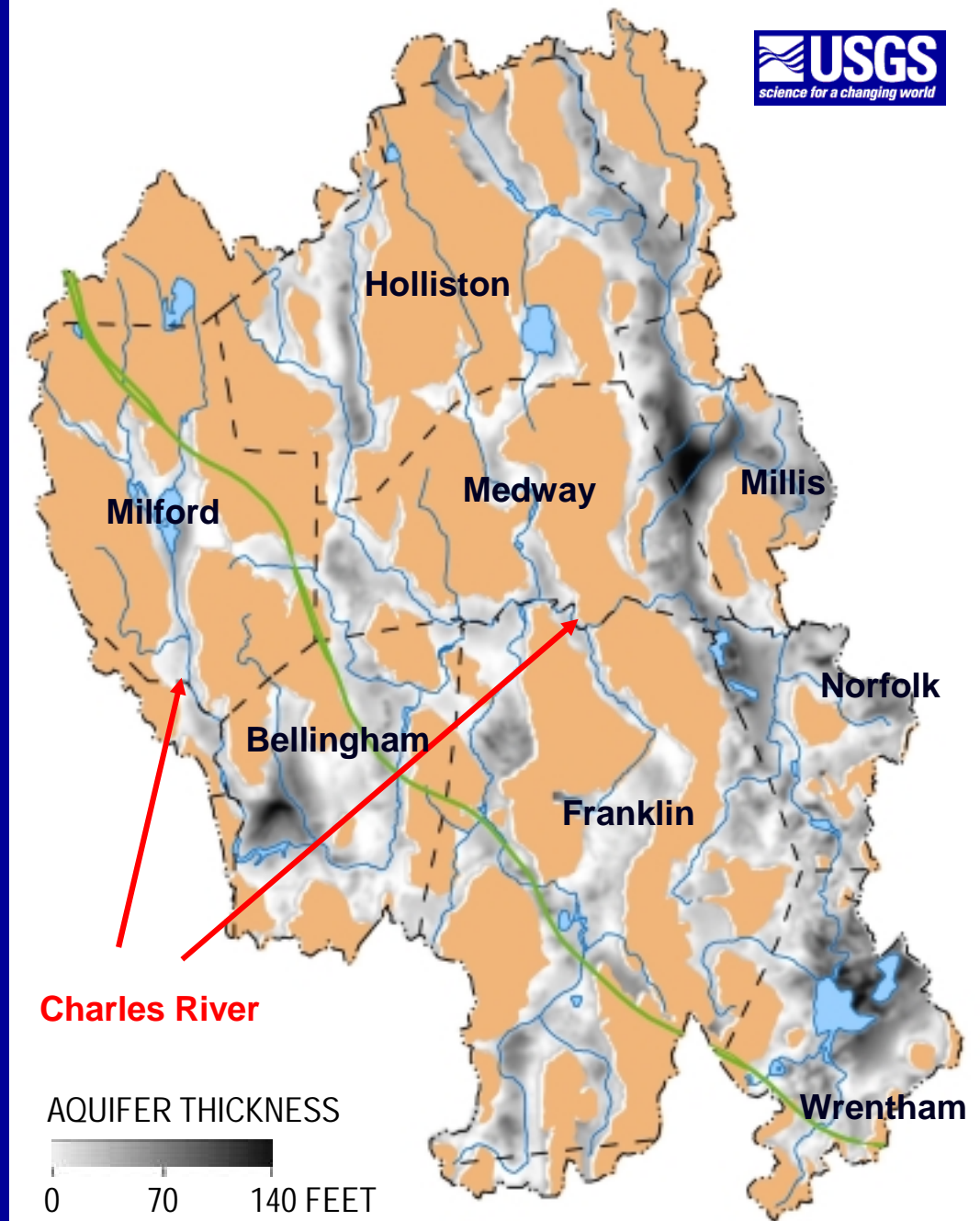


### 3. Aquifer Storage:

#### Upper Charles River Basin

- Thin, discontinuous sand & gravel deposits
- In contact with streams, lakes, and wetlands

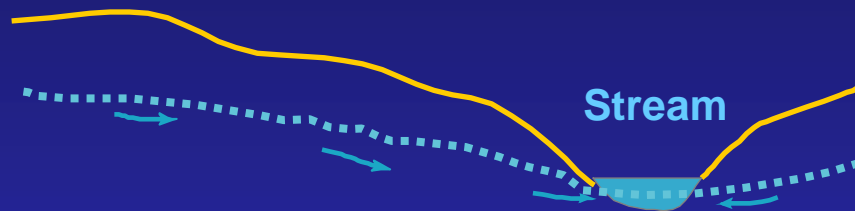
(DeSimone and others, 2002)



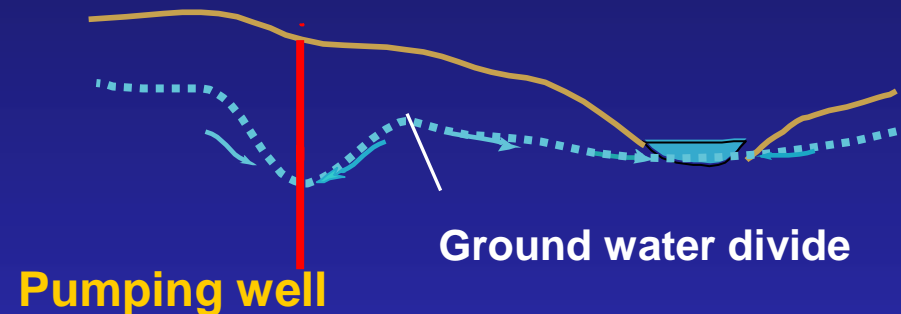


# Streamflow depletion—one possible result of these interacting factors...

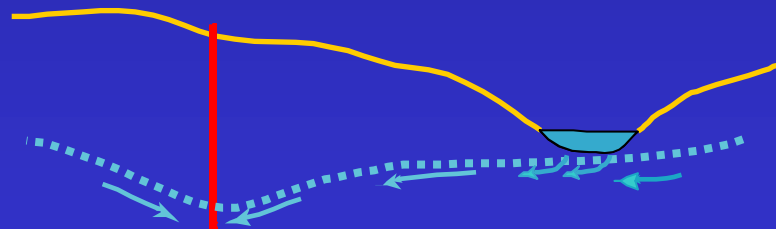
1. Pre-development



2. Captured baseflow



3. Induced infiltration



4. Depleted storage



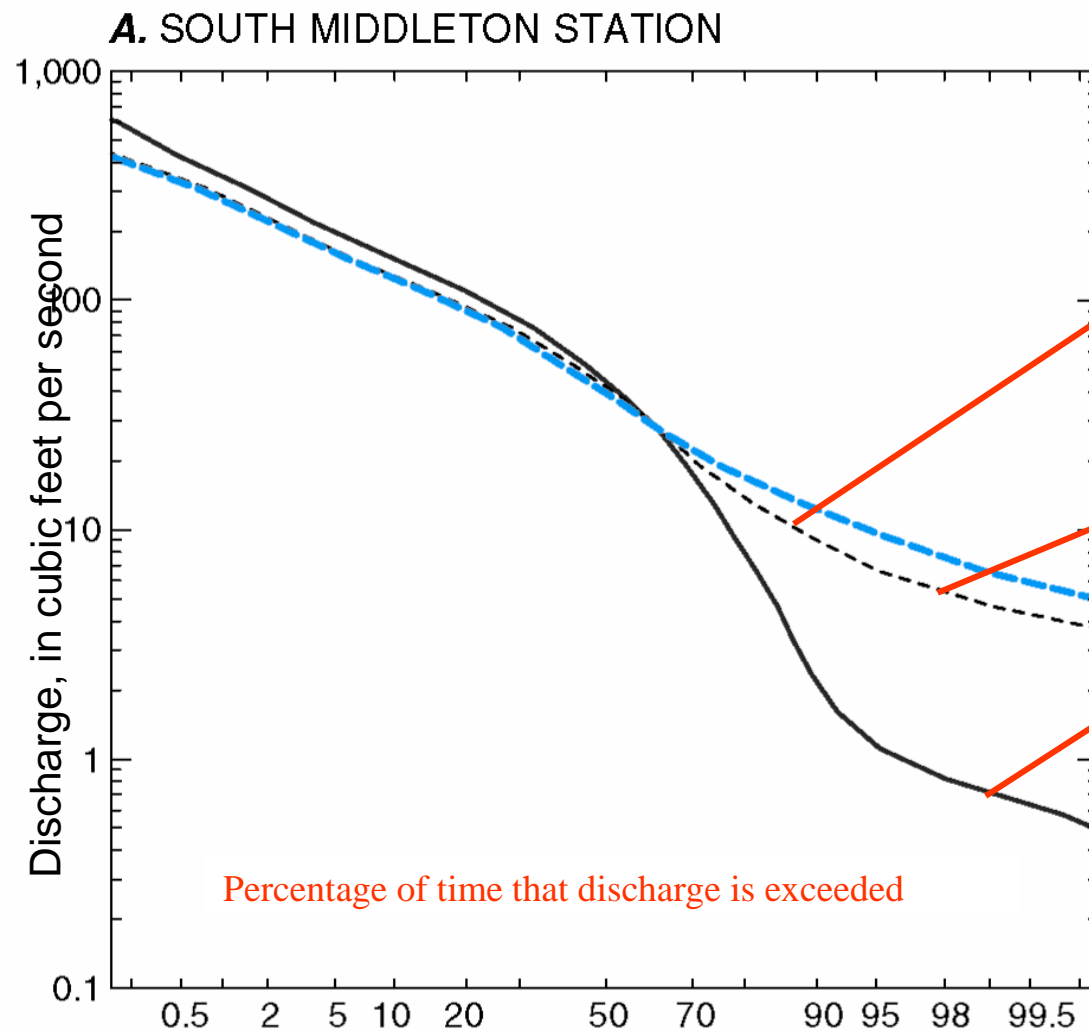
(Zarriello and Ries, 2000)

# Management solutions generally entail some combination of the following:

1. Increase recharge to aquifer.
2. Bring water use into phase with the recharge cycle (reduce summer consumption).
3. Reduce use of streamside wells in the summer; use aquifer (or reservoir) storage *away* from stream.
4. Don't export water downstream or out of basin.

*Models are useful for testing various options*

# Basin modeling: Ipswich River at South Middleton



**Simulation results for:**

**No withdrawals,  
undeveloped land use**

**No withdrawals,  
1991 land use**

**1989-93 withdrawals,  
1991 land use**

# Ipswich River Basin:

*Has raised our consciousness regarding flow and habitat...*

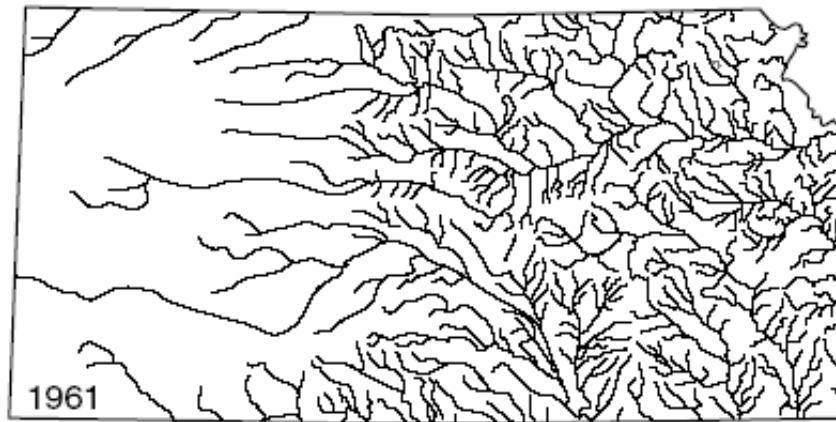


*Ipswich River near Reading, Mass., summer 1999*

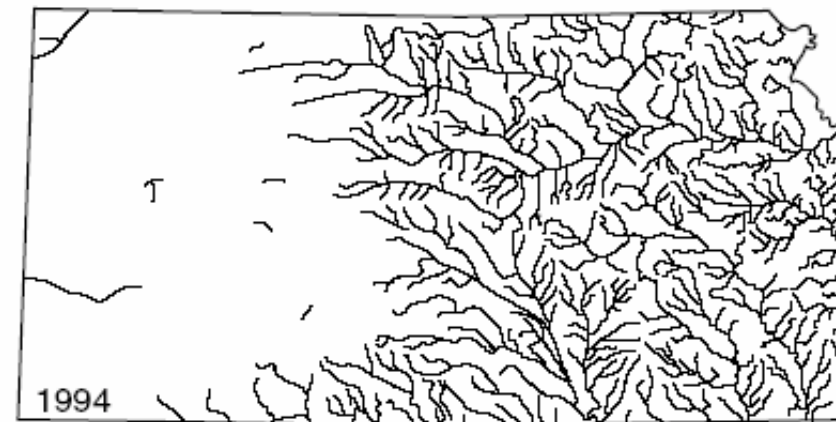
# *A question to ponder... Will Eastern Massachusetts become like Western Kansas?*

Kansas  
perennial  
streams:

1961



1994



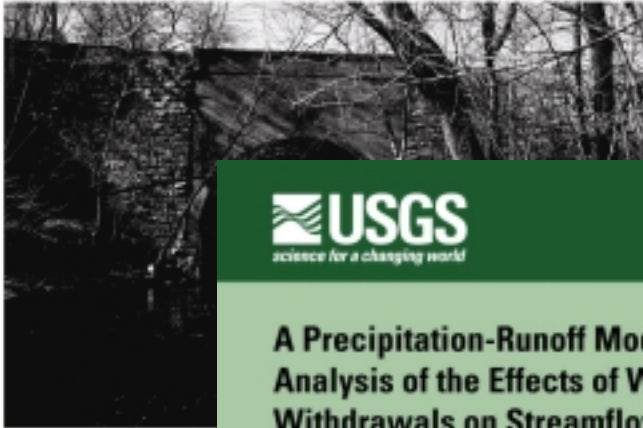
(Sophocleous, 2000)



U.S. Department of the Interior  
U.S. Geological Survey

## Simulation of Ground-Water Flow and Evaluation of Water-Management Alternatives in the Upper Charles River Basin, Eastern Massachusetts

Water-Resources Investigations Report 92-4258



In cooperation with the  
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL  
MANAGEMENT, and the  
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION



## A Precipitation-Runoff Model for Analysis of the Effects of Water Withdrawals on Streamflow, Ipswich River Basin, Massachusetts

Water-Resources Investigations Report 00-6029

Prepared in cooperation with the  
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL MANAGEMENT, and the  
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION



U.S. Department of Interior  
U.S. Geological Survey

# USGS Basin Modeling and Habitat Reports:

<http://ma.water.usgs.gov>

(click on publications)